

## NASA's Strategic Goals

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- Fly the Space Shuttle as safely as possible until its retirement, not later than 2010.
- Complete the International Space Station, accommodating international partner commitments and human exploration.
- Develop a balanced overall program of science, exploration, and aeronautics consistent with the new focus on human exploration.
- Bring a new Crew Exploration Vehicle into service after Shuttle retirement.
- Encourage partnerships with the emerging commercial space sector.
- Return to the Moon and make it a base for later missions to Mars and beyond.

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## Program Description

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The NASA Robotics Academy is an intensive resident summer program of higher learning for college undergraduate and graduate students interested in pursuing professional and leadership careers in robotics-related fields.

The NASA Robotics Academy program is designed to present a comprehensive package of information and experiences about the organization of the NASA Agency; some of its most important current and planned science, engineering, education, and technology enterprises; and a number of nontechnical areas of critical significance. Besides attending lectures and workshops with experts in their field, the Robotics Academy students are involved in supervised research in a Marshall Space Flight Center (MSFC) laboratory and will participate in visits to other NASA Centers and a number of robotics-related academic laboratories and industries.

## Eligibility, Selection Criteria, and Placement

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The participants in the Marshall NASA Robotics Academy have been selected based on the following criteria:

- United States (US) citizenship or permanent residency.
- Research Associates: Rising college freshman and sophomores.
- Team Leads: Junior/senior undergraduates or graduate students.
- High academic standing (GPA 3.0 or higher).
- Demonstrated prior involvement in robotics.
- Propensity for teamwork.

The selection process and placement of the Academy participants in Marshall's research groups were assisted by recommendations from faculty, administrators, academic supervisors, and coworkers, and the applicants' self-profiling essays.

## A Brief History of the NASA Robotics Academy

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The NASA Robotics Academy was founded in 2005 at the Goddard Space Flight Center (GSFC) with a vision to expand to other NASA centers. The Ames Chapter opened in 2006 and MSFC began its preliminary year of the Robotics Academy in 2007.

The Robotics Academy began with the insight that robotics plays a critical role in NASA's Space Exploration Vision. The NASA Robotics Academy provides a pathway for students interested in careers in this exciting field. It can provide a bridge from high school programs such as FIRST, Botball, and BEST to continued involvement in robotics research through undergraduate and graduate levels.

This year, the NASA Robotics Academy at MSFC will train its third generation of Research Associates, building upon the program's two years of success.

## Multirobot Systems

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The student team will assemble four robots with a computer module and radio frequency (RF) communications ability (microcontroller boards with WiFi interfaces on iRobot Create robots).

The student team will design and construct a method of performing triangulation such that a desktop PC can compute the location of each robot within a substantial 2D space (e.g., a parking lot or gymnasium).

The student team will design and program a graphical user interface capable of displaying and directing coordinated multirobot activities over multiple RF communication links using Create Open Interface Library (COIL).

As proof of successful accomplishment, the robots will be randomly placed within a bounded area, their locations will be discovered, and they will be directed to perform at least one coordinated activity.

**Principal Investigator:** Robert E. Ray

**Team Lead:** Armando Hernandez

**Research Associates:** Robert Rucker  
Katherine Blackburn  
Lars Osborne

## Armando Hernandez

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### Capitol College

Laurel, MD

Computer Science, Master of Science, 2012

### College of Southern Maryland

La Plata, MD

Engineering AS, Computer Science Minor, 2010

### Saint Mary's College of Maryland

St Mary's City, MD

Physics BA, 2006; Teaching MA, 2007

Email: ajhernandez@smcps.org



## Research and Experience

- **Distributed Swarming Robotic System**
  - Coordinate movement of multiple iRobot Create to perform synchronized tasks or clean up debris.
- **Electromagnetically Induced Transparency**
  - Used a multitude of optical devices to super cool and slow down Rubidium atoms to trap them in a magneto-optics trap to help advance research and development techniques for gyroscopes on NAVY submarines.
- **Self Efficacy and Motivation Amongst Test Anxious Middle Schoolers**
  - Tested to see whether there was a correlation between self-efficacy and motivation and test anxiety in middle school students in today's schools.

## Membership and Activities

- The Planetary Society
- PADI Diving Society
- National Space Society
- Aircraft Owners and Pilots Association

## Honors and Awards

- Eagle Scout
- Flight Attendant Certificate of Achievement
- Locksmith
- US Space Camp's "The Right Stuff" Award

## Special Skills

- Software Tools
  - Microsoft Office
  - Several CAD programs
- Programming Languages
  - C++
  - Visual Basic
  - JAVA
  - JavaScript

## Hobbies

Robotics, video games, building models, computer programming

## Personal Statement

I was born in Puerto Rico on January 12, 1984 to Armando and Carmen Hernandez. My father was a police officer and my mother was a medical technologist. I am the oldest of three. I have a younger brother named Roberto and a younger sister named Yelitza. We grew up on the island until I was about 6 years old when my mother joined the Army and moved us to El Paso, Texas. She later transferred into the Navy and we were relocated to San Diego, CA. We later were moved to St. Mary's County, MD where I now currently reside.

All throughout my schooling years, I was a high achiever. I scored top in almost all of my classes. I obtained many achievements along the way, including the rank of Eagle Scout and a physics award. In 2002, I graduated high school in the top 1% of my class and began to pursue my dreams of becoming an astronaut by becoming a Navy pilot. I went to the Naval Academy upon graduation. Unhappy with my choice of school, I rerouted my college career to attend St. Mary's College of Maryland. I heard about the educator astronaut program with NASA and decided to try to pursue my dream through that route. I graduated in 2006 with a B.A. in physics and then in 2007 with an M.A. in teaching. I began to teach physics at the high school I attended and have been teaching there ever since. In order to increase my chances of getting into NASA's astronaut program, I currently started my track toward getting a M.A. in Computer Science and in Aerospace Engineering.

Upon graduating from college, I met up again with my high school sweetheart, Stephanie. After courting for some time, we married in 2008 and decided to settle down in St. Inigoes, MD. We live here with our dog, Daisy. We excitedly expect to be parents in October 2010.

## Robert Rucker

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### University of Illinois at Urbana-Champaign

Electrical and Computer Engineering

Master of Engineering

### Vanderbilt University

Nashville, TN

Electrical Engineering

Bachelor of Engineering 2010

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## Research and Experience

- **German Academic Exchange Service**—RISE Intern, June–August 2009
  - Assisted a German PhD student on his dissertation at the University of Oldenburg in Oldenburg, Germany.
  - Wrote a MATLAB program that simulates a hybrid system.
  - Gave a report to the DAAD at the end of my internship.
- **NASA Robotics Academy MSFC**—Research Associate, June–August 2008
  - Constructed static and kinematic models of R-Gator and other autonomous systems using RoboSim2.
  - Presented results to a research symposium at the end of summer.
  - Wrote a simulation of an unmanned devices demonstration
  - Built a new activity for Space Camp.
- **Advanced Engineering**—Intern, Summer 2007
  - Fabricated controls for various clients including Bridgestone, Mars Pet Care, and PermaPipe.
  - Fabricated panels and mounted PLCs on panels.
  - Programmed PLCs in RSLogix using Ladder Logic programming.
  - Helped draft panel tags using AutoCAD.

## Membership and Activities

- **Wesley/Canterbury Fellowship**, 2006–2010
  - President, 2009–2010
- **Vanderbilt Student Volunteers for Science**—Team Lead, 2006–2010
- **Habitat for Humanity**—President, 2005–2006

## Honors and Awards

- Deans List: Each semester at Vanderbilt University
- Tau Beta Pi
- Eta Kappa Nu
- Dillard Jacobs Scholarship

## Special Skills

- Software Tools
  - AutoCAD
  - MATLAB
  - MS Office Professional and Visual Studio
- Computer Languages
  - C/C++
  - Java/JavaScript
  - Ladder Logic
  - Assembly
  - MATLAB
- Electronics
  - Circuit design
  - Digital logic
  - Programmable Logic Controllers (PLCs)

## Hobbies

Reading, writing, ultimate frisbee, bowling, movies, hiking, biking, bass guitar

## Personal Statement

My name is Rob Rucker and I am, among other things, a graduate of Vanderbilt University who majored in electrical engineering and minored in astronomy. I will be attending the University of Illinois at Urbana-Champaign in the fall of 2010, pursuing a master's degree in electrical and computer engineering on a teaching assistantship. I am no stranger to Robotics Academy; I attended during the summer of 2008. The summer before that, I worked at an engineering firm near my home, Advanced Engineering, as a panel shop worker. The summer of 2009, I had the opportunity to assist a German Ph.D. student on his dissertation at the University of Oldenburg, Germany. I created a MATLAB tool to simulate a hybrid system so he could check his models. I also got to explore beautiful Germany, which was a great experience in itself. Now I am returning to Robotics Academy for another fun summer. I spend what little free time I can find reading, playing bass guitar, and writing, among many other pursuits.

## Katherine Blackburn

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### Louisiana State University

Baton Rouge, LA  
Electrical Engineering  
Math and German Minor  
Bachelor of Science 2012  
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### Research and Experience

- **LA-ACES High Altitude Ballooning Project**, Fall 2007–Aug 2008
  - Designed, built, programmed and flew a 12-lb high-altitude balloon package to test the atmosphere
- **LSU ITS Helpdesk**—Student Analyst, Aug 2008–present
  - Assist customers via phone calls and walkups at the official LSU Helpdesk.
- **LSU Parallax Research Group**—Researcher, Aug 2008–present
  - Currently learning to program in C and C++.
  - Researching more efficient ways to make many computers work in parallel.
- **LSU in Germany**, June–July 2009
  - Spent 5 weeks in Germany studying German Language and German Civilization.

### Membership and Activities

- **BREC Baton Rouge Zoo**—Volunteer
- **Tutoring for Math**—SI Tutoring for Calculus

### Honors and Awards

- TripleX Symposium Poster Presentation Award
- Chancellor's Aide Alumni Scholarship, LSU
- LA-STEM Researchers Scholarship, LSU
- TOPS Tuition Opportunity Program for Scholars

### Special Skills

- Software Tools
  - Microsoft Office and Publisher
  - Symantec Ghost V8 image creator
  - Mathematica
  - Windows, MAC, Ubuntu
- Computer Languages
  - C/C++
  - BASIC

- Electronics
  - Soldering
  - Building Circuit Boards
  - Identifying Electrical Components

### Hobbies

- Reading
- Biking
- Swimming
- Rock Climbing
- Hiking

### Personal Statement

I am currently a junior majoring in Electrical Engineering at Louisiana State University. I have taken classes in circuit theory, electronics, digital logic, and computer programming. In addition to my interest in engineering, I am also pursuing minors in German language and literature and Mathematics. I am also a LaSTEM scholar, a prestigious, 4-year scholarship program for Science, Technology, Engineering and Mathematics students who plan to pursue a masters or Ph.D. in their field. I plan on graduating from LSU in Spring 2012 and after this will continue my education in the form of either a masters or Ph.D.

I recently completed work as a student worker in the LaACES program, which is designed to give students a real-world image of physics and engineering along with several real world skills. LaACES is a selective program that is run by Louisiana State University's Physics department by Doctors John Wefel and Gregory Guzik, and, in this program, I work with a group of 2 others to measure the electrical conductivity of the atmosphere from surface to 100,000 feet in order to eventually compare levels of conductivity to pollution and possible storm activity more accurately. It has been necessary for me to apply information from my circuit theory and electronics classes to design and construct the circuit schematics and final circuit boards for the payload, as well as information from my Computer programming classes to help program the processes of the payload during flight. In the fall, I will continue this project and investigate the best way to measure conductivity as well as trends in conductivity versus altitude.

## Lars Osborne

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**Montana State University**  
Bozeman, MT  
Mechanical Engineering  
Bachelor of Science 2012  
Email: lars.osborne@gmail.com



### Research and Experience

- **Jet Propulsion Laboratory**— Summer Intern, Summer 2009
  - Planned, developed, and executed software tests for the two analytical instruments on board the Mars Science Laboratory.
  - Developed using software tools and executed on both software simulations and hardware models.
  - Determined the validity of the software simulations of the hardware instrument simulations, which expedited software development.
- **Montana State University Space Science Engineering Laboratory**— Mechanical Engineer, September 2007–Present
  - Assisted in structural analysis of in-house designed structure.
  - Discovered critical design flaw in the attitude control system of a cube sat and moved to fix the problem while optimizing performance.
  - Ran analysis of different attitude control system configurations.

### Membership and Activities

- **Interhall Residence Hall Association**— VP of Technology, May 2008–February 2010
  - Work with other students to improve life on campus.
  - Organize campus-wide events and activities.
  - Manage technological equipment and Web site.

### Honors and Awards

- Member of University Honors Program

### Special Skills

- Software Tools
  - Pro-Engineer
  - Solid Works
  - MATLAB
  - MathCAD
  - PSPICE
  - Excel
- Programming Languages
  - BASIC
  - Java
- Electronics
  - Soldering
  - Multimeters
  - Oscilloscopes
  - Wave function generators

### Hobbies

Snowboarding, reading (economist, technical books, and historical adventures), kayaking, climbing, taking things apart, legos, exploring new places, tea, and chocolate

### Personal Statement

I was born and raised in Fairbanks, Alaska. I am currently attending Montana State University where I am majoring in mechanical engineering and minoring in aerospace engineering and electrical engineering. I love being outdoors and enjoy snowboarding, rock climbing, and biking. My favorite indoor activities are playing video games and cooking. Someday I hope to feel as though I have made significant contributions to human development as a species and perhaps travel into space.

## Reconfigurable Computing Telepresence Robot

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The student team will assemble a robot using an existing MARCbot robotic platform, a Xilinx Virtex-6 evaluation board, a webcam (ACTi IP camera), a wireless router (ex. LinkSys), and a commercial off-the-shelf (COTS) power supply board.

The student team will implement a software routine to translate a command stream received over a WiFi TCP/IP connection such that the MARCbot movement can be directed remotely. This will require writing a Linux-based embedded control program executing on the XUPV5.

The student team will design and program a graphical user interface capable of translating movement commands from a joystick interface (Xbox controller) and transmit these movement commands to the MARCbot while displaying the image stream received from the ACTi camera.

Bonus points for both teams for integrating the MARCbot with the Create swarm bots.

**Principal Investigator:** Robert E. Ray

**Team Lead:** Patrick Scott

**Research Associates:** Ellen Farber  
Taylor Courier  
Eric Kurz

## Patrick Scott

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### Tuskegee University

Tuskegee, AL

Mechanical Engineering

Bachelor of Science 2010

Email: pascott53@yahoo.com



### Research and Experience

- **Hanger**—Prosthetist Assistant, February 2010–present
  - Initiating and executing construction of prosthetic limbs and orthopedic equipment.
- **Tuskegee University**—Research Assistant, 2009–present
  - Analyzing and determining several feasible programs for Vex Robotics Cameras.
  - Researching nano-composite material under Tuskegee University Centre for Advance Materials.
- **NASA Jet Propulsion Laboratory**—Design Engineering Group (355G), Summer 2009
  - Advanced Mirror Development Project.
  - Mars Sample Return Project:
    - Developed, conducted, and reported break and score test for project.

### Membership and Activities

- Central Alabama Veterans Health Care System
- After-School Tutoring
- Community Service
- Institute of Electrical and Electronics Engineers (IEEE)
- National Society for Black Engineers (NSBE)
- Tuskegee Football

### Honors and Awards

- Proctor & Gamble Technical Scholarship
- Tuskegee Achievement Scholarship
- Tuskegee Honor Roll
- NACME Scholarship
- Alumni Miscellaneous Scholarship
- United Technologies Scholarship

### Special Skills

- Software Tools
  - Microsoft Office
  - Unigraphics Design Software
- Programming Languages
  - C++
  - Easy C

### Hobbies

Fixing and Operating Motorcycles and Sports Cars

### Personal Statement

Patrick Ahmaad Scott was born in South Fulton Hospital in College Park, Georgia on January 31, 1988. He is the second of four children for Patrick and Donna Scott. As a child, he was very quiet, curious, and he had an elaborate imagination. Often times he would be punished for disassembling objects and unable to put them back together properly. Growing up, one could easily see Patrick's fascination in robots. He would build models and watch television shows such as Mega Man, Transformers, Zoids, and Robotech. At one point, through the influences of these television shows, he even imagined himself as being part cyborg. He would walk around in boxes and pretend that he was a robot. As he progressed through school he earned As and Bs and was often seen on the honor roll. Outside of school he indulged in extra circular activities such as football, flying airplanes, building models, and watching robotic television shows.

Patrick graduated from Eagles Landing High School in May of 2006. The following summer, he entered Tuskegee University FASTREC program, which is an accelerated summer school program for gifted incoming freshmen in the engineering field. While attending Tuskegee, he majored in mechanical engineering and obtained many high honors. In his spare time at Tuskegee, he indulged in robotics, football, and motorcycles. Through his extracurricular activities, his passions in the field of robotics began to grow. Often times he would work with his robotics professors after hours on vex robotics. Also, he would spend time studying Dean Kamon and ponder on ideas of Ironman and Transformers. Soon afterwards, he began to search and apply for graduate school programs in the field of robotics.

Through hard work and dedication, Patrick achieved acceptance into Worcester Polytechnic Institute (WPI). He plans on attending there this fall after his robotics internship with NASA Robotics Academy. After he completes his journey at WPI, he plans to attend technician school for automotive and motorcycles since he also enjoys that as a hobby. After the completion of his education, he plans on working for NASA in the field of robotics and running an exposure program part time to underprivileged youth.

## Ellen Farber

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### Harvard University

Cambridge, MA

Computer Engineering

Bachelor of Science 2013

Email: efarber@college.harvard.edu



### Research and Experience

- **Acquia**—Intern, January 2010–May 2010
  - Created a Drupal Web interface to manage internal projects.
  - Wrote custom modules for Drupal Web sites.
- **Rice University RiSYS Engineering Lab**—Research Assistant, June 2009–August 2009
  - Designed and implemented a project to test oil pipeline integrity using magnetic flux leakage.
  - Analyzed magnetic flux leakage data using MATLAB.
  - Devised method to analyze pipeline integrity.
- **Digital Literacy Project**—Technology Chair, 2009–2010
  - Coordinated technology assistance for two local pilot programs.
  - Organized technology assistance for a pilot program in Nicaragua.
  - Trained students and teachers to use XO Laptops.
  - Programmed an XO Laptop math activity using PyGame.

### Membership and Activities

- Competitive bowling
- Women in Science
- RoboCup Team

### Honors and Awards

- Lamar High School Robotics Team
  - Community Outreach Coordinator
  - Electronics Captain for FIRST Robotics Competition:
    - 1st place in 2009
    - Founder for FIRST at Lamar High School
- Phi Beta Kappa Scholarship
- Society of Women Engineers Texas State Scholarship

### Special Skills

- Software Tools
  - Microsoft Word and Excel
  - MATLAB
- Programming Languages
  - C
  - JAVA
  - Web Programming
  - Python
  - MySQL
- Robotics
  - Programming
  - Electronics
  - Mechanics
  - Hobbies
  - Bowling, reading, soccer

### Personal Statement

Ellen Farber is a rising sophomore at Harvard University who is planning to major in computer science. She was born and raised in Houston, Texas where she graduated as Salutatorian from M.B. Lamar High School. She helped start a FIRST Robotics Team at her high school during her junior year and led the team to a first place finish at the 2009 Lone Star Regional Competition. She also conducted research on the integrity of oil pipelines at Rice University over the summer. Before this summer, she was interning for Acquia, an open source software company that provides products, services, and technical support for the open source Drupal social publishing system.

## Taylor Courier

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### North Carolina State University

Raleigh, NC

Computer Engineering

Bachelor of Science 2013

Email: tmcourie@ncsu.edu



### Research and Experience

- **Mobile Autonomous Robotic Sensing System (MARSS)**, 2008–2009
  - Designed, built, programmed, and tested mobile robot to locate radiation sources in the environment.
- **Micro-Wind Generator Utilizing Aeroelastic Flutter**, 2007–2008
  - Designed and built a device to generate electricity from non-rotational (linear) motion.
- **Autonomous Positioning System for a Modulated Laser**, 2006–2007
  - Designed, built, and programmed an automatic alignment system for laser audio transmitter.
- **Enlightened Sound: Transforming Sound into Light**, 2005–2006
  - Designed, built, and tested a device to transmit audio signals over a modulated laser beam.

### Membership and Activities

- NC State Mechatronics Course—Teacher
- FIRST Robotics Team Member, 2005–2009

### Honors and Awards

- **International Sustainable World (Energy, Engineering, and Environment) Project (ISWEEEP)**
  - 2009 Silver Medal
  - 2008 Bronze Medal
- **International Science Fair**—Finalist 2007, Fair Ambassador 2006
- **Carl Sandburg Home National Historic Site 2004 Project**—Eagle Scout Rank
  - Built stairs on dangerous section of trail.
  - Resurfaced trail to protect tree roots and improve hiking safety.

### Special Skills

- Programming Languages
  - Assembly
  - Binary
  - C/C++

- Java
- Python
- Maple
- MATLAB
- HTML
- CSS
- PBasic, QBasic, TIBasic

### Hobbies

Kayaking, Mountain Climbing, Biking, Swimming, Photography, Reading, and Parkour

### Personal Statement

I am a sophomore in Computer Engineering at North Carolina State University in Raleigh. I graduated from the North Carolina School of Science and Mathematics in 2009. My 2 years at this public, residential science-and-math focused high school were an amazing experience.

I first became interested in robotics when I received a Lego Mindstorms Robotic Invention System as a gift in middle school. Quickly intrigued, I then progressed to the Vex robotics system. When I entered high school, I joined our county's FIRST Robotics team, where I worked on the mechanical, electrical, and programming teams. The summer after my freshman year in high school, I attended the Mechatronics Engineering summer course at the University of North Carolina at Asheville. In this 60-hour intensive class, we designed, built, programmed, and tested small autonomous mobile robots to compete against those made by other students in the class. The next summer, I was the only high school student to be invited to help teach the course. Continuing my participation in FIRST Robotics both years at NCSSM, I was the mechanical team leader my senior year.

Throughout high school, I also conducted various robotics and technology related research projects. My senior research project, entitled "Mobile Autonomous Robotic Sensing System (MARSS)," was to design, build, and test a mobile autonomous robot to locate radiation sources in the environment and provide real time sensor data to a remote human operator. This project earned me various awards at the school, regional, state, and international levels, including a Silver Medal and a special industry award at the ISWEEEP.

## Eric Kurz

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### Worcester Polytechnic Institute

Worcester, MA

Robotics Engineering

Mechanical Engineering Minor

Bachelor of Science 2011

Email: [eric@ekurz.com](mailto:eric@ekurz.com)



## Research and Experience

- **Formulatrix**— Intern, Summer 2009
  - Helped design and test new sensors.
  - Redesigned the MUVIS Microscope.
  - Designed and built an air control supply.
- **Worcester Polytechnic Institute**, Summer 2009
  - Assisted with the creation of a Robotics resource Web site <<http://thinktank.wpi.edu/Portal>>.
  - Member of the staff of robotics summer camps for high school students.
- **ACT Associates**, Mansfield, CT, March–September 2006
  - Created CAD drawings of audio-visual designs.
  - Designed camera placement for Houston Zoo.
- **FIRST Robotics Team 190**, WPI— Mentor, 2007–Present

## Membership and Activities

- **FIRST Robotics Team 1373**, E.O. Smith High School, 2004–2008
  - Team Mentor, design analysis and manufacturing advice, 2008
  - Team President and Subgroup leader, 2005–2007
- American Indian Housing Initiative
- Technology Student Association
- WPI Outing Club

## Honors and Awards

- WPI Charles O. Thompson Scholar
- Rensselaer Medal
- Worcester Polytechnic Institute University Award Recipient

## Special Skills

- Software Tools
  - Solid Works
  - AutoCAD
  - Microsoft Office
  - Maya
- Programming Languages
  - C
  - Java

## Hobbies

Travelling, hiking, rock climbing, skiing, and jewelry making

## Personal Statement

Eric M. Kurz will be entering his senior year in the Robotics engineering program at Worcester Polytechnic Institute (WPI) in Worcester, MA where he is a Charles O. Thompson scholar, in the fall of 2010. He graduated from E.O. Smith High School in Mansfield, CT where he played soccer for 2 years and was a 4-year member of the FIRST robotics team and its captain for 2 years. His participation in FIRST has continued into college, where he is a mentor for the Mass Academy team and a volunteer at regional events. Recent academic projects have included the design and construction of robots including one that navigates mazes, one that searches for and extinguishes a lit candle, and another that maps an area in order to facilitate navigation. For Eric's interdisciplinary qualifying project, he collaborated on the development of the RoboKids curriculum that introduces disadvantaged middle school students to Science Technology and Engineering (STEM) concepts. Previous internships include working at WPI on building an online resource library for FIRST teams and aiding in the development of protein crystallography instrumentation at Formulatrix in Woburn, MA.

## Lunar Wormbot Project Proposal

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As NASA strives to learn more about the Moon, there are specific challenges that must be overcome. One key activity for obtaining lunar samples for scientific study is tapping deep into the regolith. However, lunar regolith is a difficult substrate to drill into, given its intrinsic properties. Regolith is abrasive, well integrated (becoming denser with increasing depth), is magnetic, readily sticks to surfaces (via electrostatic force), and contains all size materials from the submicron level to large boulders and can thus easily jam conventional drills. In order to obtain samples at depths beyond the distances reached by conventional drilling methods, we propose to design, build, and test a prototype burrowing robotic platform consisting of a piezoelectric ultrasonic drill, an auger, and multiple elongating segments that mimic the peristaltic motion of an earthworm.

Several of the elements that comprise our design come from combining multiple ideas, each individually suggested for use in space exploration. The proposed design utilizes the advantageous features from each existing idea to form a novel platform for subsurface exploration on the Moon. We intend to design a drill bit able to both loosen the regolith and fracture large rocks that are encountered, similar to the operation of a jackhammer. We propose the use of a piezoelectric ultrasonic drill because ultrasonic drills can operate in broad temperature ranges, consume low power (5-10W), require low preload force, and can easily cut materials such as basalts. Given the narrow bore of ultrasonic drill bits, we will include a tapered auger in our design to displace the regolith, facilitating the robot's ability to tunnel. Each segment will include a single force-controlled linear actuator, enabling the wormbot to move along a single direction of motion. These worm-like sections can provide the necessary force exertion required for tunnel boring, a problem faced but not overcome in previous drilling robot designs. The drill, auger and segment control sequences will be executed either by an onboard microcontroller or a computer with a data acquisition card to control basic burrowing behavior.

**Principal Investigator:** Jessica Gaskin

**Team Lead:** Michael Kuhlman

**Research Associates:** Lafe Zabowski  
Blaze Sanders

## Michael Kuhlman

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### University of Maryland at College Park

College Park, MD

Electrical Engineering

Master of Science 2012

Email: mkuhlman@umd.edu

### Rensselaer Polytechnic Institute

Troy, NY

Electrical Engineering

Bachelor of Science 2009

Email: mjkuhlman@alum.rpi.edu



## Research and Experience

- **Maryland Engineering Research Internship Teams (MERIT BIEN),**  
Summer 2009
  - Developed and integrated control laws with an active sonar system on a mobile robot in MATLAB and MDLe inspired by bat echolocation.
  - Awarded second place for best overall project in MERIT fair.
- **New York Space Grant Summer Intern at Jet Propulsion Laboratory,**  
Summer 2008
  - Modeled cerebellar control for passive dynamic walkers traversing rough terrain using MATLAB.
  - Advised ground-breaking shadow biometrics research team by providing benchmark review of biometric techniques based on gait.
- **Maryland Engineering Research Internship Teams (MERIT RITE),**  
Summer 2007
  - Researched methods to determine physical traits of a walking subject from gait biometrics using computer vision techniques.

## Membership and Activities

- Elected Treasurer, Formula Hybrid — RPI Chapter
- RPI Symphonic Band — French Horn

## Honors and Awards

- Eta Kappa Nu National Electrical and Computer Engineering Society
- Tau Beta Pi National Engineering Honor Society
- Graduated Magna Cum Laude from Rensselaer Polytechnic Institute
- Eagle Scout

## Special Skills

- Software Tools
  - MATLAB
  - Tekkotsu
  - LaTeX
  - Linux
  - Mathcad
  - LabVIEW
- Programming Languages
  - Python
  - C/C++
  - FORTRAN90
  - Visual BASIC
- Other
  - Scientific Dataset Construction & Data Acquisition
  - Circuit Debugging
  - Robotics
  - Systems Integration
  - Modeling and Numerical Simulation
  - Interdisciplinary Research
  - Computer Vision
  - Team Management
  - Hobbies
  - French horn, writing, cooking, outdoor activities, and weightlifting

## Personal Statement

Michael Kuhlman has recently earned a B.S. in electrical engineering at Rensselaer Polytechnic Institute, and will attend the University of Maryland starting in the fall of 2010 to pursue a Ph.D. in robotics. His research interests focus on different aspects of intelligent behavior in robots, from vision to control and cognitive science. He has had three internships with NASA in previous summers: two at Goddard Space Flight Center during high school, and one at the Jet Propulsion Laboratory. In his spare time, Michael plays the French horn, writes, and hikes. He likes building things from electronics to model rockets, participates in the skeptical movement (promotes science education), and sometimes goes to the gym to offset his geeky habits.

## Lafe Zabowski

### Embry-Riddle Aeronautical University

Daytona Beach, FL

Mechanical Engineering

Master of Science 2011 (4.0 GPA)

Aero/Astronautical Engineering

Bachelor of Science 2008

Email: lafe.zabowski@my.erau.edu



## Research and Experience

- **Master's Thesis: Application of a New Human Intelligence Theory (Hierarchical Temporal Memory) to Create an Autonomous Hexapod Robot (ERAU), 2009–2011**
  - A new theory of human intelligence developed by Jeff Hawkins is being implemented on a hexapod platform to prove that cognition, be it human or machine, can be purely based on storing sensed patterns in memory, recognizing said patterns, and the ability to recollect them when a new, cohesive pattern is sensed.
- **Design and Development of the Mechanical Interface Between Parts of the Foldable Limbs of a Transformable Hybrid Robot (TU), 2007**
  - In order to create the folded limb of a transformable walking/rolling robot, a clever system of hinges was designed that did not limit the workspace of the limb in leg mode and formed a circular wheel while in wheel mode. Aided by SolidWorks CAD models, the most appropriate design was implemented on the robot. Once the design was completed, assistance was provided to the postdoctoral researcher in assembling and testing the robot.
- **Experimental Study of the Gripping Properties of a Hexapod Robot on Different Soil Characteristics (TU), 2006**
  - This project concerned JAXA's Hayabusa MK II mission, which consisted of dropping a robot on an asteroid for exploration purposes. To simulate the microgravity environment, a hexapod was mounted on an impedance controlled manipulator arm. Utilizing the force sensors and a mounted camera to determine the total time of contact, the gripping properties of the robot were determined on different soil characteristics.

## Membership and Activities

- Embry-Riddle Robotics Association, Embry-Riddle Study Abroad Honor Society, IEEE, American Society of Mechanical Engineers, American Institute of Aeronautics and Astronautics

## Honors and Awards

- Junior Year Program in English (JYPE) September 2006–August 2007
  - Tohoku University (TU), Sendai, Japan, Dr. Kazuya Yoshida's Space Robotics Laboratory
- Dean's List, Summer 2005, Spring 2008, Summer 2009, Fall 2009, Spring 2010

## Special Skills

- Software Tools
  - LabVIEW,
  - SolidWorks,
  - CATIA,
  - NEI-NASTRAN,
  - Maple,
  - MATLAB,
  - Simulink
- Programming Languages
  - C
  - C++
  - Java
  - Python

## Personal Statement

As a graduate student in the field of mechanical engineering and a veteran of two renowned collegiate robotics research laboratories, my interests lie in the field of autonomous mobile robotics, more specifically, in walking robots. My reasons for pursuing this interest are to improve upon the capabilities of autonomous walking robots in order to positively contribute to humanity, whether to help save lives in times of war and when natural disasters occur or to expand our knowledge of the origins of the universe and ourselves by using them to explore the solar system and beyond.

My current research is based on a new theory of intelligence proposed by Jeff Hawkins in his 2002 book, *On Intelligence*. The theory, known as Hierarchical Temporal Memory (HTM), explains how the hierarchical structure of the neocortex in the brain builds a model of the world and uses this model for inference and prediction.

My future plans are to elaborate further upon my current research as a doctoral student. I would like to include additional intelligent features such as object recognition, a more detailed obstacle avoidance system, people and moving object tracking, and a path planning system all incorporating the HTM theory. I am hopeful that my current and future research will be a pioneering effort that will help produce more intelligent and robust walking robots that are capable of learning but are not overly complex and can be created in a cost effective manner.

## Blaze D. Sanders

### Johns Hopkins University

Baltimore, MD

Electrical Engineering

Computer Engineering

Bachelor of Science 2010

Email: bsande11@jhu.edu



### Research and Experience

- **NASA Johnson Space Center**—Computer Programmer, June–August 2009
  - Coded HSI Scorecard, a computer program used to evaluate multiple subsystems within the Orion program.
- **N.Y. State Department of Transportation**—Student Engineering Intern, May–August 2008
  - GPS data collection and creation of G.I.S ArcvView Maps.
  - Performed State road inspections.
- **Baker Center for Learning**—Tutor, August 2006–May 2008
  - Accomplished math, life science, and CS tutor with certification.

### Membership and Activities

- Science is for Everyone—Math and Science outreach program
- Ready, Set, Design—Women in engineering outreach program
- High School Aerospace Scholar Mentor/Co-op
- President of JHU IEEE Student Chapter
- President of Mars Society Chapter at JHU
- President of Johns Hopkins Amateur Radio Club
- Membership chair for National Society of Black Engineers

### Honors and Awards

- NASA M.U.S.T. Scholar
- Invitation to the International Scholar Laureate Program Delegation on Engineering in China
- President's Citation, Dean's List
- Phi Theta Kappa, Eta Kappa Nu, Tau Beta Pi

### Hobbies

Skydiving, SCUBA diving, rappelling, model rockets, wrestling, Mars related self-projects, Ham Radio, and GNU radio

### Special Skills

- Software Tools
  - LabVIEW,
  - MATLAB

- Programming Languages
  - C++
  - JAVA,
  - Visual BASIC
  - PBASIC
  - CPLD
  - PLC

### Personal Statement

I hope to gain perspicacity in as many areas as possible. My dream educational goal is to earn a bachelor's degree in aerospace, chemical, and electrical engineering, with a minor in computer science and geology. With two additional master's degrees in yet undecided areas. During my summer research opportunity I hope to gain a deeper understanding of orbital mechanics, Sabatier and Reverse Water Gas Shift reactors, mineral deposition, ascent guidance strategies, space systems, robotic vision, and avionics. Honestly, I'm interested in learning any and everything space related. In this way, I can continue my quest to facilitate advancement in manned space flight, and one day generate new knowledge about Mars. With my all-encompassing knowledge, I envision becoming a well-qualified astronaut, and one upping Neil Armstrong. A deep understanding of all Martian processes, In situ resource utilization methods and simple oxygen extraction methods, such as wetting Martian soil, will allow for successful human exploration. I believe we should be designing hardware, software, and protocol for Mars, with the idea of testing it on the Moon if need be. However, testing on earthly Mars analogs (NEMO, FMARS or MDRS), may be quicker and more efficient. I'm optimistic that being a multi-disciplinary, athletic scientist/engineer, with an understanding of the importance of social interaction, will aid me in becoming a NASA Exploration Astronaut. This is a goal I have had since I could talk. Just check the family home videos. I live and would risk my life for space, it's humankind's only future.

A few activities that show my commitment/experience in engineering and science include my personal library collection on Mars. I'm also currently using three astronomy books to design a computer program that performs celestial coordinate system transformations, time conversions, and calculates/defines seletnographic coordinates. In addition, I'm a coproject leader for my Johns Hopkins team in the NASA Space Elevator Centennial Challenge and the project leader for the NASA Moon Work Design Contest. I have also designed a small-scale Martian Airlock system using a PLC. The second self-project is a Mars ground penetrating radar (GPR) rover that can be used to search for liquid subterranean water. It will include a methane/volatile organic compound sensor and will use its GPR radio equipment to act as a beacon for atmospheric entry of manned spacecraft on Mars.

The human will to explore and solve the impossible is what makes us so special. We can't sit back and let the universe control us. We must spread and protect life and the will to live!

### Program Director

*Chrissa K. Hall*

Chrissa Hall manages the Marshall Center Cooperative Education Program. She joined NASA in 1986 as a co-op student in Marshall's Office of Chief Counsel. In 1987, she was assigned to Marshall's Procurement Office where she later became a contract specialist and a full-time employee in 1991. In 2000, Hall was appointed training consultant and manager of the Cooperative Education in the Marshall Learning and Organizational Development Office, where she served until assigned to her current position in 2004.

The Knoxville, TN Native earned an associate's degree in office administration from Calhoun Community College in Decatur, AL in 1987, and a bachelor's degree in business administration from Athens State University in Athens, AL in 1991. She and her husband Tim reside in Hartselle, AL. She enjoys traveling, working out at the gym, shopping and spending time with family.

### Program Manager

*Dr. Gerald R. Karr*

Dr. Karr is a professor of mechanical and aerospace engineering at the University of Alabama in Huntsville (UAH). Since 1992, Dr. Karr has also served as the UAH Campus Director of the ASGC. Dr. Karr also served as the Chair of the Mechanical and Aerospace Engineering Department at UAH from 1986 through 1999. Dr. Karr has, since 1978, been the University Director of the highly successful NASA Summer Faculty Research Opportunity (NSFRO) program. Dr. Karr has also been an active researcher in the areas of satellite drag, high-energy lasers, cryogenics, spacecraft thermal design and computational fluid mechanics. Dr. Karr earned his B.S. (1964), M.S. (1966), and Ph.D. (1969) in Aeronautical and Astronautical Engineering at the University of Illinois at Champaign-Urbana. For recreation, Dr. Karr enjoys golf, running, sailing, and visiting with his children and grandsons.

### Operations Manager

*Jessica Tham*

Jessica is an alumna of the 2008 and 2009 NASA Robotics Academy at MSFC. She will graduate in May 2011 from Louisiana Tech University with a bachelor of science degree in Mechanical Engineering. During the last academic quarter, Jessica worked on a NASA-related project related to UV radiation damage of DNA. For her final undergraduate year, she plans to work with a multidisciplinary team of undergraduate engineers on a NASA-related Capstone Design Project. After graduation, Jessica will apply to work for a position at any of the NASA centers and pursue a master's degree in business.

"My ultimate life goal is to still be alive and kickin' when we, as a human race develop force field, transportation, and warp technology. After all, Space is the "final frontier," so let us explore it together." —Jessica Tham

- **NASA MSFC Robotics Academy:**  
<http://robotics.msfc.nasa.gov/>
- **NASA Robotics Academy Alumni Association:**  
<http://www.roboticalumni.org/>
- **NASA Academy Alumni Association:**  
<http://www.nasa-academy.org/>
- **NASA Agency:**  
<http://www.nasa.gov>
- **NASA Marshall Space Flight Center:**  
<http://www.msfc.nasa.gov/>
- **Botball Robot Competition:**  
<http://www.botball.org/>
- **For Inspiration and Recognition in Science and Technology:**  
<http://www.usfirst.org/>
- **International Space University:**  
<http://www.isunet.edu>
- **The Soffen Memorial Fund:**  
<http://www.nasa-academy.org/soffen/fund.html>

